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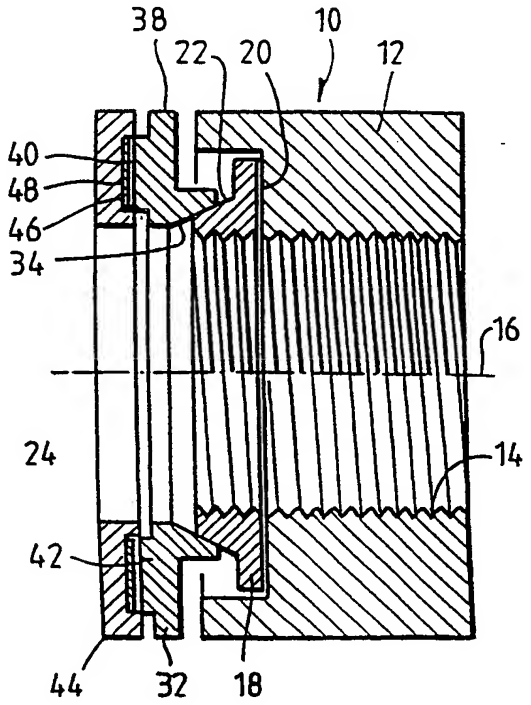
(54) Title: SELF-LOCKING NUT ASSEMBLY

(57) Abstract

A self-locking nut assembly (10) capable of resisiting inadvertent loosening due to vibration or cyclic loading. The assembly (10) comprises a head portion (12) adapted to receive as panner or wrench for tightening or loosening the assembly on a bolt or stud, and an internal threaded portion (14) provided in connection with the head portion (12). The assembly (10) further comprises a locking member (18) in the form of a locking washer comprising two halves (26) of semi-circular shape. The locking member (18) has an outer peripheral surface (22) that is inclined with respect to an axis of rotation (16) of the head portion (12), and also has an inner surface (24). A thrust member (32) bears against the locking washer (18), and has an inner peripheral surface (34) designed to engage with the outer peripheral surface (22) of the locking washer (18). When an axial compressive load is applied to the locking member (18), for example, by tightening the assembly on a threaded fastener, the respective peripheral surfaces engage to create a wedging effect, wherein the inner surface (24) of the locking member (18) is forced against the thread of the fastener on which the assembly is being tightened, so as to grip the thread and inhibit loosening due to vibration.



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SELF-LOCKING NUT ASSEMBLY

FIELD OF THE INVENTION

The present invention relates to a self-locking nut assembly designed to inhibit inadvertent loosening due to vibration and/or cyclic loading and relates particularly, though not exclusively, to such a self-locking nut assembly employed as a wheel nut.

BACKGROUND TO THE INVENTION

A known self-locking nut, sold under the trade mark **NYLOX** (trade mark of), comprises a nut having a washer made of plastics material, typically nylon, provided in connection therewith. The washer is fixed to an outer end of the nut and has an inside diameter equal to or slightly smaller than the root diameter of the nut thread. When the **NYLOX** nut is started on the thread of a bolt or stud a thread must first be cut in the washer before the nut can be threaded fully onto the bolt or stud. Hence the washer offers a degree of resistance to turning both during tightening and loosening, due to the cutting friction and resilient pressure of the newly cut plastics material on the thread of the bolt or stud. However, after the **NYLOX** nut has been screwed on and off several times, the thread in the washer turns too freely to lock the nut and no longer offers any resistance to inadvertent loosening due to vibration or cyclic loading. This type of nut is therefore of limited utility, particularly when the nut must be regularly tightened and loosened. It is recommended to use this type of nut once only.

Motor vehicle wheel nuts often need to be repeatedly tightened and loosened in order to remove or replace a wheel, particularly on heavy transport vehicles, such as semi-trailer trucks where the tyres must be regularly changed or rotated. Motor vehicle wheel nuts are also prone to inadvertent loosening due to vibration and/or cyclic loading.

The present invention was developed with a view to providing a self-locking nut assembly that can be repeatedly tightened and loosened, but that will continue to provide resistance to inadvertent loosening due to vibration and/or cyclic loading.

SUMMARY OF THE INVENTION

According to the present invention there is provided a self-locking nut assembly comprising:

a head portion for tightening and loosening the assembly by rotating about an axis of rotation of the head portion;

an internal threaded portion provided in connection with said head portion;

a locking member that bears against said head portion, said locking member having an inner surface concentric with said internal threaded portion and adapted to move inwardly when an axial load is applied to the locking member;

whereby, in use, when an axial compressive load is applied to the locking member, for example, by tightening the assembly on a threaded fastener, said inner surface of the locking member is forced against the thread of the fastener on which the assembly is being tightened, so as to grip the thread and inhibit loosening due to vibration.

In one embodiment said locking member has an outer peripheral surface that is inclined with respect to said axis of rotation of the head portion and said self-locking nut assembly further comprises a thrust member that bears against said locking member, said thrust member having an inner peripheral surface designed to engage with said outer peripheral surface of the locking member whereby, in use, when an axial compressive load is applied to the locking member said respective peripheral surfaces engage to create a wedging effect, wherein said inner surface of the locking member is thrust against the thread of the fastener on which the assembly is being tightened.

Advantageously said locking member is in the form of a washer comprising two halves of semi-circular shape, and wherein prior to the application of an axial load a gap exists between the two halves so that, in use, when said axial load is applied said gap allows the two halves to move towards each other due to said wedging effect. In one embodiment, the locking member is made from a resilient material, however in another embodiment the locking member is made from metal or some other suitable rigid or semi-rigid material.

Preferably said locking member is assembled in connection with the head portion so as to be non-rotatable with respect to the head portion. For example, the head portion of the assembly may be formed with a hexagon-shaped recess adapted to receive said locking member therein, and said locking member may be formed with a matching hexagon-shaped outer circumferential edge. Preferably said locking member has an internal thread that continues the internal thread of said threaded portion.

Typically said outer peripheral surface of the locking member is an annular surface of decreasing diameter in the direction of tightening of the assembly, preferably of frusto-conical configuration. Preferably said inner peripheral surface of the thrust member is of similar configuration to said outer peripheral surface of the locking member, except that the maximum diameter of the inner peripheral surface is smaller than the maximum diameter of the outer peripheral surface, whereby sliding movement of the outer peripheral surface over the inner peripheral surface can be accommodated under an applied axial load.

In an alternative embodiment, said locking member is in the form of a lock washer made of resilient material, said lock washer being of non-planar configuration and having a first side surface that bears against said head portion and a second side surface on the opposite side of the washer, said second side surface being axially spaced from said first side surface by a distance greater than a minimum thickness

of the washer, wherein an axial compressive load applied to the locking member can cause said second side surface to move axially with respect to said first side surface, which in turn causes said inner surface to move inwardly whereby, in use, said inner surface of the locking member is forced against the thread of the fastener on which the assembly is being tightened.

In one form of the latter embodiment the lock washer has a radially curved cross-section and said first and second side surfaces are formed on a concave and a convex side of the washer respectively. The application of a compressive load tends to flatten the lock washer. Preferably the lock washer is accommodated within a recess in the under-surface of the head portion of the assembly, said recess preventing any outwards movement of an outer peripheral surface of the washer during the application of a compressive load.

BRIEF DESCRIPTION OF THE DRAWINGS

In order to facilitate a more thorough understanding of the nature of the invention, several illustrative embodiments of the self-locking nut assembly will now be described, by way of example only, with reference to the accompanying drawings in which:

Figure 1 illustrates an embodiment of the self-locking nut assembly according to the invention;

Figure 2 is an exploded view of the self-locking nut assembly of Figure 1;

Figure 3 illustrates a locking washer employed in the self-locking nut assembly of Figures 1 and 2;

Figure 4 illustrates another embodiment of the self-locking nut assembly according to the invention; and

Figure 5 illustrates a still further embodiment of the self-locking nut assembly according to the invention.

DETAILED DESCRIPTION OF PREFERRED EMBODIMENTS

Figures 1 and 2 illustrate an embodiment of the self-locking nut assembly 10 according to the present invention. The assembly 10 comprises a head portion 12 adapted to receive a fastening tool, for example, a spanner or wrench for tightening or loosening the assembly on a bolt or stud (not shown). The assembly 10 further comprises an internal threaded portion 14, provided in connection with the head portion 12, and a locking member 18 that bears against a first pressure transmitting surface 20 of the head portion 12. The locking member 18 has an outer peripheral surface 22 that is inclined with respect to an axis of rotation 16 of the head portion 12, and also has an inner surface 24.

In this embodiment, the locking member 18 is in the form of a locking washer comprising two halves 26 of semi-circular shape as illustrated in Figure 3. Preferably the inner surface 24 of the locking washer 18 has an internal thread that continues the internal thread of the threaded portion 14 of the assembly. Hence, in use, the locking washer 18 simply screws onto the thread of the bolt or stud together with the threaded portion 14 provided integral with the head portion 12 of the nut assembly. In this embodiment the locking washer 18 is assembled in connection with the head portion 12 so as to be non-rotatable with respect to the head portion 12. This is achieved by forming the head portion 12 with a hexagon-shaped recess 28, adjacent the first pressure transmitting surface 20, which is adapted to receive the two halves 26 of the locking washer therein. As can be seen in Figure 3, the two halves 26 of the locking washer 18 are formed with a matching hexagon-shaped outer circumferential edge 30 adapted to be received in recess 28 of the head portion, so that the locking washer 18 rotates with the head portion 12 as the assembly is tightened or loosened on a bolt or stud.

The self-locking nut assembly 10 of this embodiment further comprises a thrust member 32 that bears against the locking washer 18, the thrust member 32 having an inner

peripheral surface 34 designed to engage with the outer peripheral surface 22 of the locking washer 18. As can be seen most clearly in Figure 3, the outer peripheral surface 22 of locking washer 18 is an annular surface of decreasing diameter in the direction of tightening of the assembly, and is of substantially frusto-conical configuration. The inner peripheral surface 34 of thrust member 32 is typically of a similar configuration to the outer peripheral surface 22 of locking washer 18, except that the maximum diameter of the inner peripheral surface 34 is smaller than the maximum diameter of the outer peripheral surface 22, so that sliding movement of the outer peripheral surface 22 over the inner peripheral surface 34 can be accommodated under an applied axial load. When an axial load is applied to the assembly 10, for example, by tightening of the assembly on a threaded fastener (not illustrated), the respective peripheral surfaces 22, 34 engage to create a wedging effect, wherein the threaded inner surface 24 of the locking washer is thrust against the thread of the fastener (not illustrated) on which the assembly is being tightened so as to grip the thread and inhibit loosening due to vibration. As the axial load applied to the locking washer 18 increases, so too the wedging effect increases causing the inner surface 24 of the locking washer 18 to grip the thread of the fastener more tightly. This self-locking feature of the nut assembly 10 means that the likelihood of the assembly inadvertently loosening due to vibration and/or cyclic loading can be significantly reduced. The wedging effect is further enhanced by forming the two halves 26 of the locking washer 18 in such a way that, prior to the application of an axial load, gaps 36 exists between the two halves so that when the axial load is applied the gaps 36 allow the two halves to move towards each other due to the wedging effect. Typically, the thrust member 32 is provided with an outer circumferential gripping surface 38 of similar shape to an outer circumferential gripping surface of the head portion 12, so that the thrust member 32 can be gripped by a

fastening tool and rotated together with the head portion 12 of the assembly. For example, the outer surface 38 of the thrust member 32 and the outer surface of the head portion 12 may both be toothed, or may have a series of flats as in a conventional hexagon nut. It will be obvious that both the outer peripheral surface 22 of locking washer 18 and the inner peripheral surface 34 of thrust member 32 both also act as pressure transmitting surfaces, when a clamping pressure is applied by the first pressure transmitting surface 20 of the head portion 12. Preferably, the angle of inclination of the peripheral surfaces 22, 34 is selected so that substantial clamping pressure is transmitted via the thrust member 32 to the object to be fastened, while still producing an adequate wedging effect.

In this embodiment, thrust member 32 is provided with a second pressure transmitting surface 40 formed on an annular spigot-like protrusion 42 provided on an underside of the thrust member 32. This embodiment of the nut assembly incorporates a bearing assembly similar to that described in commonly owned International Application No. PCT/AU92/00586, the disclosure of which is incorporated herein by reference. The bearing assembly comprises a first part formed by thrust member 32, having said second pressure transmitting surface 40, and a second part in the form of an annular member 44 having a third pressure transmitting surface 46, and adapted to rotatably receive the second pressure transmitting surface 40 of the first part in facing relation thereto. A solid dry lubricant or friction reducing material 48 is provided between the second and third pressure transmitting surfaces 40, 46 whereby, in use, the first part 32 can rotate with the head portion 12 of the assembly and the second part 34 can be held stationary relative to the fastened object so that the friction reducing material 48 can act as a bearing between the head portion 12 of the assembly and the fastened object. In this embodiment the solid dry lubricant material 48 is provided in the form of an annulus and the annular member 44

is provided with an annular recess or channel 50, sized to receive the annulus 48 therein.

The structure and operation of a fastener bearing assembly similar to that illustrated in Figures 1 and 2 has been fully described elsewhere and will not be described again in detail here, suffice to say that the bearing assembly incorporated in the self-locking nut assembly 10 of this embodiment significantly decreases the turning friction between the assembly and the object to be fastened, as it is tightened or loosened on the bolt or stud, therefore reducing the torque required to tighten or loosen the nut assembly. However, when the axial load applied to the locking washer 18 via pressure transmitting 20 of the head portion 12 increases, and the inner surface 24 of the locking washer starts to grip the thread of the bolt or stud, the torque required to tighten the nut assembly will increase as the wedging effect comes into play. However, the strength with which the locking washer is thrust against the thread of the fastener by the wedging effect can be limited to a maximum by carefully designing the angle of inclination of the outer and inner peripheral surfaces 22, 34 and the size of the gaps 36 between the two halves 26 of the locking washer 18. Thus the torque required to tighten the nut assembly will not increase indefinitely due to the wedging effect as the axial load on the locking washer 18 increases. Preferably the angle of inclination of the peripheral surfaces 22, 34 is designed so that the wedging effect does not become significant or come into play until the maximum torque is applied during, for example, the last turn of the head portion 12 during tightening. The torque required to tighten the nut assembly 10 will continue to increase until the required pretensioning of the bolt or stud is achieved, due to the friction between the thread of the threaded portion 14 of the nut assembly and the thread of the bolt or stud.

The locking member 18 of this embodiment is formed in two halves 26 having gaps 36 therebetween. However, the locking member 18 may also be formed in one piece and made

from a resilient material, for example, a plastics material such as nylon, which can accommodate an inwards movement of the locking member as it is thrust against the thread of the fastener on which the assembly is being tightened, due to the wedging effect. Clearly, when the locking member 18 is formed in two or more pieces with gaps therebetween it can be made from any suitable material, for example metal, since the inwards movement of the locking member as it is thrust against the thread of the fastener due to the wedging effect, is accommodated by the gaps. The locking member may be formed in two or more pieces with one or more gaps therebetween, and need not be in the form of a washer, but may comprise two or more pieces uniformly spaced apart so as to grip the bolt or stud uniformly about its circumference when an axial load is applied. Furthermore, it is not essential that the locking member 18 be provided with an internal thread on its inner surface 24. Thus, for example, if the locking member 18 is formed of resilient plastics material, an internal thread may be cut in the inner surface 24 when the nut assembly 10 is screwed onto the thread of a bolt or stud, as with a conventional **NYLOX** nut. It is also not essential that the locking member be made non-rotatable with respect to the head portion 12.

In the illustrated embodiment of Figures 1 to 3, the thrust member 32 is formed with an internal diameter slightly greater than the outer diameter of the thread of the bolt or stud on which the assembly 10 turns. Hence the thrust member 32 is always free to move axially with respect to the head portion 12. However, in an alternative embodiment the thrust member 32 is also provided with an internal thread and is screwed onto the thread of the bolt or stud with the threaded portion 14. In this alternative embodiment it becomes necessary to rotate (screw) the thrust member relative to the head portion 12 (and locking member 18) or vice versa in order to apply an axial load to the locking member 18 and bring the wedging effect into play. Therefore, in practice the assembly can first be tightened on

the bolt or stud by turning the head portion 12 and thrust member 18 with the torque required to achieve the necessary hold down pressure, and then as a second step, the head portion 12 is turned whilst the thrust member 32 is held stationary to apply an axial load to the locking member 18 to bring the wedging effect into play. With this arrangement it becomes possible to locate the locking member 18 and thrust member 32 at the other (outer) end of the assembly, since the thread on the thrust member 32 enables it to apply an axial load to the locking member 18.

Normally the entire self-locking nut assembly 10 is held together in its assemble condition by suitable means whereby the annual member 44, at least, is free to rotate with respect to the head portion 12 of the assembly. However, for clarity the embodiment has been shown in simplified form in order to illustrate the basic principles of the invention. The self-locking nut assembly of the invention is particularly suitable for replacing a conventional wheel nut, which is frequently subject to vibration and/or cyclic loading. Unlike a **NYLOX** nut, the illustrated embodiment of the self-locking nut assembly can be manually screwed onto a bolt or stud until finger tight. Advantageously, the assembly only needs to be rotated a small distance, once it is seated snugly against the object to be fastened, in order to bring the wedging effect into play.

Figure 4 illustrates another embodiment of the self-locking nut assembly 60 according to the invention. In this embodiment, inwards movement of an inner surface 62 of a locking member 64 is achieved in a different manner from the wedging effect of the first embodiment. The self-locking nut assembly 60 of this embodiment comprises a head portion 66 for tightening and loosening the assembly on a bolt or stud (not shown) and an internal threaded portion 68, provided in connection with the head portion. In this assembly 60 the locking member 64 is in the form of a lock washer made of resilient material. The lock washer 64 is of non-planar configuration and has a first side surface 70 that

bears against the head portion and a second side surface 72 on the opposite side of the washer, and which is axially spaced from the first side surface by a distance greater than the thickness of the washer. In this embodiment this spaced apart configuration of the respective side surfaces is created by the lock washer having a radially curved cross section, with the first and second side surface being formed on the concave and convex sides of the washer 64 respectively. When an axial compressive load is applied to the lock washer 64 the second side surface moves axially with respect to the first side surface 70 as the compressive load tends to flatten the lock washer. This flattening of the lock washer 64 causes the inner surface 62 of the lock washer to move inwardly so that, in use, the inner surface 64 is forced against the thread of the fastener (not shown) on which the assembly 60 is being tightened, so as to grip the thread and inhibit loosening due to vibration.

The lock washer 64 is accommodated within a recess 74 in the under-surface of the head portion 66 of the assembly. The recess 74 prevents any outwards movement of the outer peripheral surface of the washer during the application of a compressive load.

Substantially the same effect can be achieved by forming the lock washer in a frusto-conical configuration. In such an embodiment the first side surface may be formed proximate an outer peripheral edge of the lock washer, whilst the second side surface is formed proximate an inner peripheral edge of the lock washer. Alternatively said first side surface may be formed proximate an inner peripheral edge of the lock washer and the second side surface may be formed proximate an outer peripheral edge of the lock washer. In either case, the lock washer is preferably located within a recess formed in the under-surface of the head portion of the assembly, so that the flattening effect caused by an axial compressive load produces a radial inwards movement of the inner surface of the locking member to force it against the thread of the fastener on which the assembly is being

tightened. The same effect can be achieved if the lock washer is of oval or elliptical cross-section.

Upon loosening of the self-locking nut assembly of this embodiment, the resilient nature of the lock washer causes it to return to its non-planar configuration in which the first and second side surfaces return to their original positions. The inner surface of the lock washer then moves radially outwardly to release the thread of the fastener on which the assembly is being tightened. Hence the nut assembly automatically unlocks itself during loosening.

In any one of the above described embodiments the self-locking effect can be supplemented by incorporating a conventional **NYLOX** lock washer in the assembly. However, instead of having the plastics material washer fitted to the front of the nut, as in a conventional **NYLOX** nut, the lock washer is fitted to the back of the nut.

Figure 5 illustrates an alternative embodiment of the self-locking nut assembly which operates in a similar manner to that of Figures 1 to 3, except that it does not have a separate thrust member. In this embodiment of the assembly 80, a head portion 82 having an internal threaded portion 8, is formed with an inner peripheral surface 86 that is inclined with respect to an axis of rotation 88 of the head portion 82. A locking member 90 has an outer peripheral surface 92 that is designed to engage with the inner peripheral surface 86 of the head portion. The inner and outer peripheral surfaces 86 and 92 are of similar configuration to the inner and outer peripheral surfaces 34 and 22 of the first embodiment.

The locking member 90 is typically made from a resilient material, for example, a plastics material such as nylon and is capable of being compressed so that an inner surface 94 moves inwardly when an axial load is applied to the locking member. When an axial compressive load is applied to the locking member 90, for example, by tightening the assembly on a threaded fastener, the inner surface 94 is thrust against the thread of the fastener by a wedging action

produced by the respective inclined peripheral surfaces 86, 92. To further enhance the locking effect one or both of the inner and outer peripheral surfaces may be coated with a low-friction material such as Teflon, or a low friction washer may be provided therebetween. The locking member 90 may also be formed in two halves as in the first embodiment.

The assembly 80 of Figure 5 is also fitted with a bearing assembly similar to that of Figures 1 and 2 which will not be described again here. The principal advantage of the embodiment of Figure 5 over that of Figures 1 to 3 is that the thrust member of Figures 1 and 2 is now incorporated in the head portion 82 of the assembly, thereby simplifying the manufacture and reducing the cost of production.

Now that several embodiments of the self-locking nut assembly according to the invention have been described in detail, it will be apparent to persons skilled in the mechanical arts that numerous variations and modifications can be made, in addition to those already described, without departing from the basic inventive concepts. For example, it will be apparent to those skilled in the mechanical arts that the peripheral surfaces 22, 34 creating the wedging effect, need not be of frusto-conical configuration as illustrated, but may be of any suitable configuration to create the wedging effect. For example, one or both of the peripheral surfaces may be curved outwardly, ie convex, so that they engage along a circular line of contact only. All such variations and modifications are to be considered within the scope of the present invention, the nature of which is to be determined from the foregoing description and the appended claims.

THE CLAIMS DEFINING THE INVENTION ARE AS FOLLOWS:

1. A self-locking nut assembly comprising:

a head portion for tightening and loosening the assembly by rotating about an axis of rotation of the head portion;

an internal threaded portion provided in connection with said head portion;

a locking member that bears against said head portion, said locking member having an inner surface concentric with said internal threaded portion and adapted to move inwardly when an axial load is applied to the locking member;

whereby, in use, when an axial compressive load is applied to the locking member, for example, by tightening the assembly on a threaded fastener, said inner surface of the locking member is forced against the thread of the fastener on which the assembly is being tightened, so as to grip the thread and inhibit loosening due to vibration.

2. A self-locking nut assembly as claimed in claim 1, wherein said locking member has an outer peripheral surface that is inclined with respect to said axis of rotation of the head portion and said self-locking nut assembly further comprises a thrust member that bears against said locking member, said thrust member having an inner peripheral surface designed to engage with said outer peripheral surface of the locking member whereby, in use, when an axial compressive load is applied to the locking member said respective peripheral surfaces engage to create a wedging effect, wherein said inner surface of the locking member is thrust against the thread of the fastener on which the assembly is being tightened.

3. A self-locking nut assembly as claimed in claim 2, wherein said locking member is in the form of a washer comprising two halves of semi-circular shape, and wherein prior to the application of an axial load a gap exists

between the two halves so that, in use, when said axial load is applied said gap allows the two halves to move towards each other due to said wedging effect.

4. A self-locking nut assembly as claimed in claim 3, wherein said locking member is assembled in connection with the head portion so as to be non-rotatable with respect to the head portion.

5. A self-locking nut assembly as claimed in claim 2, wherein said outer peripheral surface of the locking member is an annular surface of decreasing diameter in the direction of tightening of the assembly

6. A self-locking nut assembly as claimed in claim 5, wherein said inner peripheral surface of the thrust member is of similar configuration to said outer peripheral surface of the locking member, except that the maximum diameter of the inner peripheral surface is smaller than the maximum diameter of the outer peripheral surface, whereby sliding movement of the outer peripheral surface over the inner peripheral surface can be accommodated under an applied axial load.

7. A self-locking nut assembly as claimed in claim 1, wherein said locking member is in the form of a lock washer made of resilient material, said lock washer being of non-planar configuration and having a first side surface that bears against said head portion and a second side surface on the opposite side of the washer, said second side surface being axially spaced from said first side surface by a distance greater than the thickness of the washer, wherein an axial compressive load applied to the locking member can cause said second side surface to move axially with respect to said first side surface, which in turn causes said inner surface to move inwardly whereby, in use, said inner surface of the locking member is forced against the thread of the fastener on which the assembly is being tightened.

8. A self-locking nut assembly as claimed in claim 7, wherein the lock washer has a radially curved cross-section and said first and second side surfaces are formed on a concave and a convex side of the washer respectively.

9. A self-locking nut assembly as claimed in claim 8, wherein the lock washer is accommodated within a recess in the under-surface of the head portion of the assembly, said recess preventing any outwards movement of an outer peripheral surface of the washer during the application of a compressive load.

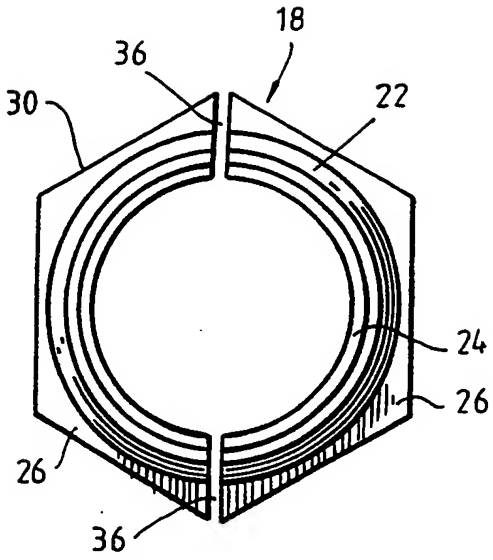

FIG. 3.

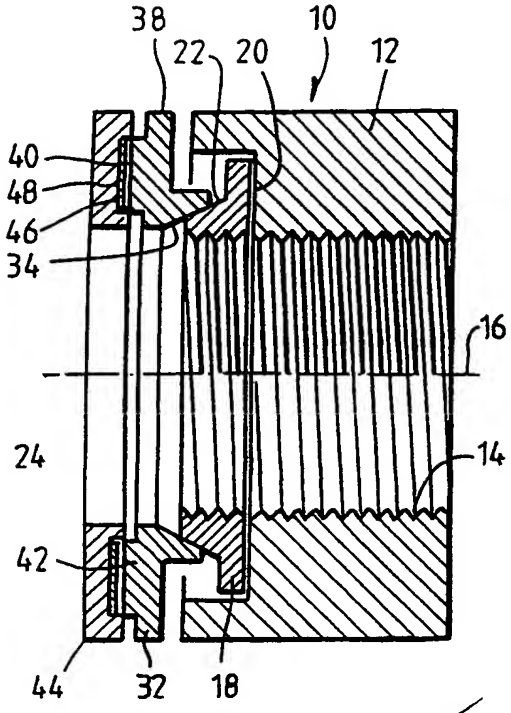

FIG. 1.

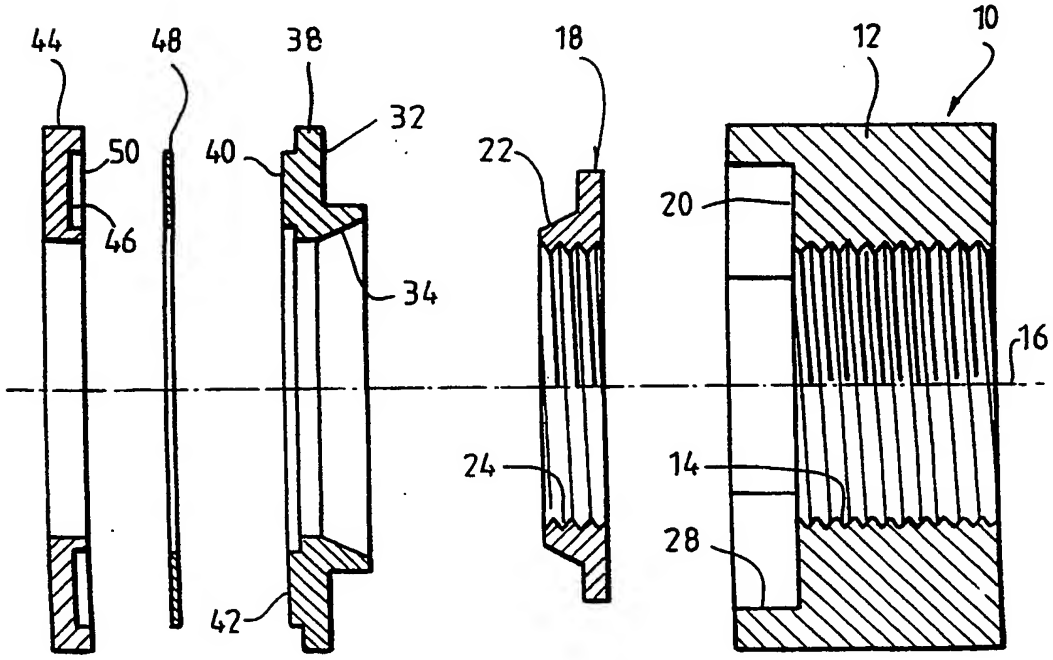

FIG. 2.

SUBSTITUTE SHEET

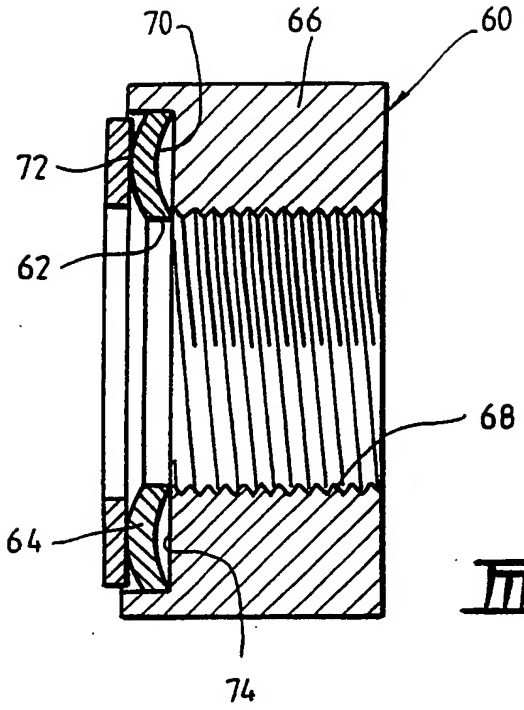

FIG. 4.

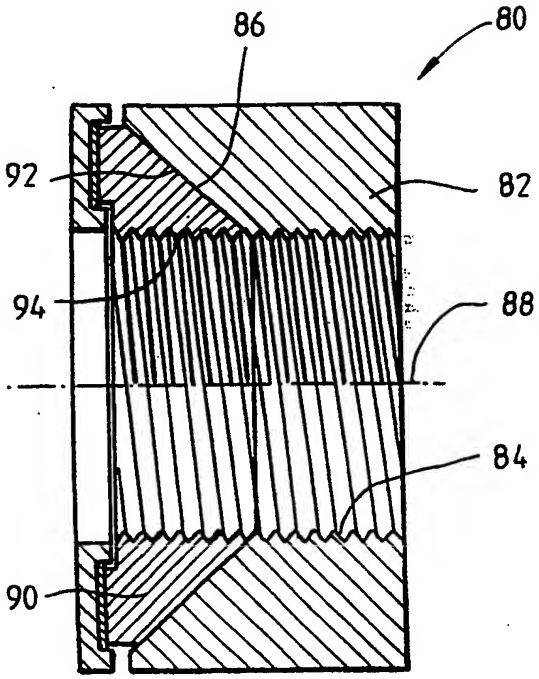

FIG. 5.

INTERNATIONAL SEARCH REPORT

International application No.
PCT/AU 93/00473

A. CLASSIFICATION OF SUBJECT MATTER
Int. Cl.[5] F16B 39/36, 39/284, 39/24

According to International Patent Classification (IPC) or to both national classification and IPC

B. FIELDS SEARCHED

Minimum documentation searched (classification system followed by classification symbols)
IPC[5] : F16B 39/36, 39/284, 39/24

Documentation searched other than minimum documentation to the extent that such documents are included in the fields searched
AU : IPC as above

Electronic data base consulted during the international search (name of data base, and where practicable, search terms used)

C. DOCUMENTS CONSIDERED TO BE RELEVANT

Category*	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to Claim No.
X	FR,A, 508300 (MALSALLEZ) 6 October 1920 (06.10.20)	1
X	FR,A, 515594 (KUGEL & BERG) 4 April 1921 (04.04.21)	1,2
X	FR,A, 710223 (DECROUY) 20 August 1931 (20.08.31)	1,7
X	FR,A, 711958 (PERRIN) 22 September 1931 (22.09.31) See figures 1,2	1
X	FR,A, 724329 (PRAGER EISEN) 25 April 1932 (25.04.32)	1

[X] Further documents are listed in the continuation of Box C.

[X] See patent family annex.

* Special categories of cited documents :

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"&" document member of the same patent family

Date of the actual completion of the international search	Date of mailing of the international search report
12 November 1993 (12.11.93)	1 DEC 1993 (1.12.93)
Name and mailing address of the ISA/AU AUSTRALIAN INDUSTRIAL PROPERTY ORGANISATION PO BOX 200 WODEN ACT 2606 AUSTRALIA Facsimile No. 06 2853929	Authorized officer David Lee Telephone No. (06) 2832107

Form PCT/ISA/210 (continuation of first sheet (2)) (July 1992) copjne

C(Continuation). DOCUMENTS CONSIDERED TO BE RELEVANT		
Category*	Citation of document, with indication, where appropriate of the relevant passages	Relevant to Claim No.
X	GB,A, 1116629 (GOODMANS LOUDSPEAKERS) 12 June 1968 (12.06.68)	1,7
X	JP,A, 51-111560 (NANIWA SEITEI KK) 10 January 1976 (10.01.76) (Japatic Abstract)	1,7
X	GB,A, 395321 (UNITED AMERICAN BOSCH CORP) 10 August 1933 (10.08.93)	1,7

This Annex lists the known "A" publication level patent family members relating to the patent documents cited in the above-mentioned international search report. The Australian Patent Office is in no way liable for these particulars which are merely given for the purpose of information.

Patent Document Cited in Search Report		Patent Family Member	
FR	724329	AU	7914/32
			END OF ANNEX